

Results of Analysis expressed in parts per 100,000.

	Total solid matter.	Organic carbon.	Organic nitro- gen.	Ammo- nia.	Nitrogen as nitrates and nitrites.	Chlorine.	Hard- ness.
Sewage No. 1	60·20	2·350	1·387	2·200	0	8·5	—
„ „ 2	84·60	7·550	4·210	3·500	0	9·6	—
Deep well-wa- ter No. 1....	43·44	0·027	0·010	0	0·446	2·5	27·2
No. 2....	42·34	0·023	0·007	0	0·442	2·5	27·9
Filt'd. Thames water.....	26·42	0·111	0·021	0	0·202	1·6	17·4

In conclusion I have to express my indebtedness to my wife for the great assistance which I have received from her in the most laborious task of estimating the colonies on the gelatine plates, amounting to nearly 1000 in number, which this investigation has entailed.

XII. "Observations on Pure Ice and Snow." By THOMAS ANDREWS, F.R.S.E., F.C.S., Wortley Iron Works, near Sheffield. Received June 10, 1886.

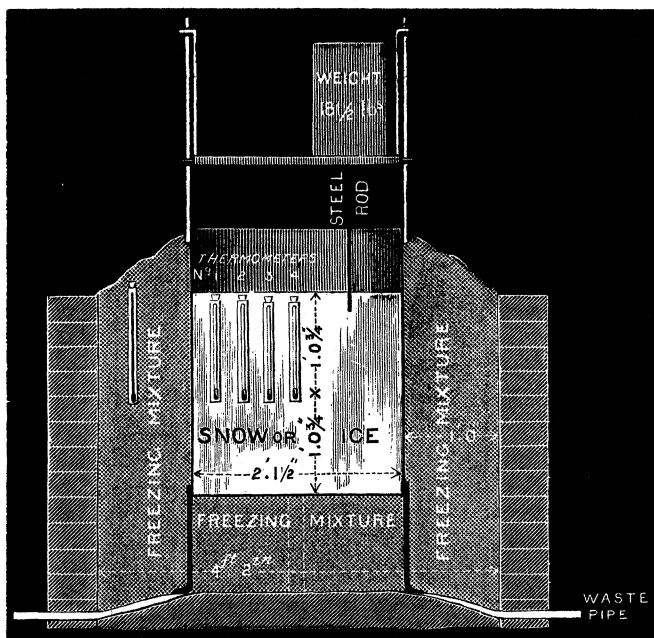
The recent very severe winter afforded favourable opportunity and material for investigating some of the properties of ice and snow. The object of the following observations was to obtain information on the relative conductivity of ice and snow, the dilatation of pure ice, and its relative hardness or penetrability at various temperatures.

SET I.—*The Relative Conductivity of Pure Ice and Snow.*

The experiments on the conductivity of the ice were made as follows:—47 gallons of distilled water at a temperature of 48° F. were placed in a large circular iron tank, A, of the internal dimensions given on fig. 1. Around this tank was built a brick enclosure, of 4 feet 2 inches internal diameter; an opening was left near the bottom for easily removing the expended freezing mixtures, &c. The intermediate space between the iron tank and the brickwork was filled with a freezing mixture of snow and salt, maintaining a constant temperature of -4° F. throughout. 18 cwts. of this mixture was required for each charge, and the charge was entirely renewed every 12 hours during the $115\frac{1}{4}$ hours needed to freeze the above volume of water. Thus about 8 tons of freezing mixture was used

for this part of the operation, producing for the experiments a cylindrical mass of pure ice 2 feet $1\frac{1}{2}$ inches diameter, having a cubic content of 8.305 feet, and weighing nearly 4 cwt. 22 lbs. A wooden frame had been securely fixed in the tank to hold the necessary tubes containing the thermometers. These were four in number, and were placed at equal distances between the centre of the circular mass of ice and its circumference, the bulbs being also midway between the top and bottom as indicated in fig. 1. The thermo-

FIG. 1.



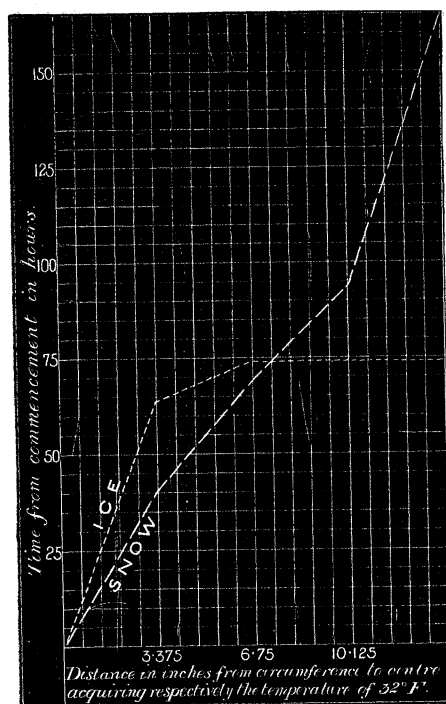
Sectional Elevation.

meters were each protected by iron pipes closed with corks. The bulb of each thermometer was immersed in mercury placed at the bottom of the pipe, the top being also closed airtight by corks. These thermometers were therefore easily removed, and replaced at the stated times of observation. As the water gradually froze, the arrangement became securely embedded in the ice.

A suitable mass of pure ice having been thus obtained, and the thermometers registering its temperature at 0° F. throughout, the freezing mixture surrounding the tank was withdrawn and its place supplied with about 15 cwt. of snow; the gradual increase in the

temperature of the ice cylinder from exterior to centre until it reached an uniform temperature of 32° F. was simultaneously periodically taken by the thermometers Nos. 1, 2, 3, and 4, and the results are graphically recorded in Table No. 1. The surface of the ice was kept covered to a depth of some inches with sawdust. $73\frac{1}{2}$ hours were required for the mass to attain the temperature of 32° F. from zero (0° F.).

Table I.—Relative Conductivity of Ice and Snow compared by the time required under equal conditions in each case for the respective mass of Ice or Snow to acquire an uniform temperature throughout.



Temperature of ice and snow cylinders at commencement = Zero (0°) F.
 Temperature surrounding ditto = 32° F.

The relative conductivity of snow was taken in a similar manner. An equal volume of fresh fallen snow was placed in the iron tank, A, and only very lightly pressed to ensure solidity of the snow, but so as to avoid regelation. Its weight was 1 cwt. 2 qrs. 14 lbs. The iron tank was then surrounded by the freezing mixture until the internal

cylindrical mass of snow was at the uniform temperature of 0° F. The freezing mixture was then removed and replaced by about 15 cwt. of snow, and the temperature readings regularly taken until the snow mass in the tank arrived at one even temperature of 32° F. throughout. The readings are delineated on Table I. $165\frac{1}{2}$ hours were occupied in arriving at this result.

The relative conductivity of the ice was thus found to be about 122 per cent. greater than the snow under the conditions of experimentation.

SET II.—*Dilatation of Ice between the Temperatures of -35° F. and $+32^{\circ}$ F.*

In conducting these experiments, the dilatation of the ice between the temperatures of zero (0° F.) and 32° F. was ascertained by the expansion of the ice measured between two iron bars 1 inch square by $19\frac{1}{2}$ inches long, securely embedded to a depth of 13 inches in the ice, and perpendicular to its surface, at a distance of $16\frac{1}{4}$ inches apart. Two other square iron bars of the same dimensions were also securely frozen horizontally into the side of the ice cylinder. The measurements between the respective sets of iron bars were accurately taken by a delicate micro-vernier gauge, the limit of error in reading which by the aid of a telescope did not exceed one two-thousandth of an inch. The gauge was securely placed on a suitable wooden frame, and thus removed from the influence of the low temperature, so that all the measurements were taken throughout at exactly the same spot on the bars. The average of 100 measurements in each case was regarded as the correct reading, and the results are recorded on Table II. After the measurements had been taken with the ice at zero (0° F.), the freezing mixture surrounding the ice tank was removed and replaced by about 15 cwts. of snow, until the whole mass of ice again reached the temperature of 32° F. The relative distances between the respective sets of bars at the higher temperature of 32° F. were again taken, and the average of 100 readings regarded as correct. The dilatation of the ice cylinder, both longitudinal and transversely, thus obtained between the temperatures of zero (0° F.) and 32° F. is given on Table II. A difference was observed between the longitudinal and transverse dilatation. This was not owing to error in observation, as the deviation was constantly noticeable during the course of the measurements. Certain crystalline bodies dilate unequally, and the ice also appeared to behave in a similar manner; the difference noticed may, therefore, possibly have been due to the mode of crystallisation of the cylindrical mass of ice.

The observations relating to the expansion of ice between -35° F. and $+32^{\circ}$ F. were conducted in a similar manner: but to obtain the lower temperature using a freezing mixture of three parts by weight

of crystallised calcium chloride and two parts of snow, which yielded a temperature of -39° F.

The vessel containing this mixture was itself further surrounded by another freezing mixture of a constant temperature of -4° F., and this arrangement was found to work admirably in maintaining a prolonged and constant low temperature. An alcohol thermometer was employed for taking the internal temperature of the mass of ice, substituting a little alcohol at the bottom of the protecting tube instead of mercury. The results are contained in Table II.

It will be noticed that the coefficients become less as the temperature is reduced.

Table II.—Dilatation of pure Ice between -35° F. and $+32^{\circ}$ F.

	Column 1.	Column 2.	Column 3.	
	Transversely measured at 32° F. become	Longitudi- nally measured at 32° F. become	Linear expansion.	
			Transverse.	Longi- tudinal.
1000 parts at $+16^{\circ}$ F...	1000·654	..	1 in 1529	—
„ zero F. ..	1001·103	1000·657	1 „ 906	1 in 1522
„ -21° F. .	1001·533	..	1 „ 652	—
„ -30° F. .	1001·712	..	1 „ 584	—
„ -35° F. .	1001·871	..	1 „ 534	—

Linear coefficient for 1° between $+16^{\circ}$ F. and $+32^{\circ}$ F. = 0·000040876.

„ „ 0 „ $+16^{\circ}$ „ = 0·000028042.

„ „ -21° „ 0 „ = 0·000020484.

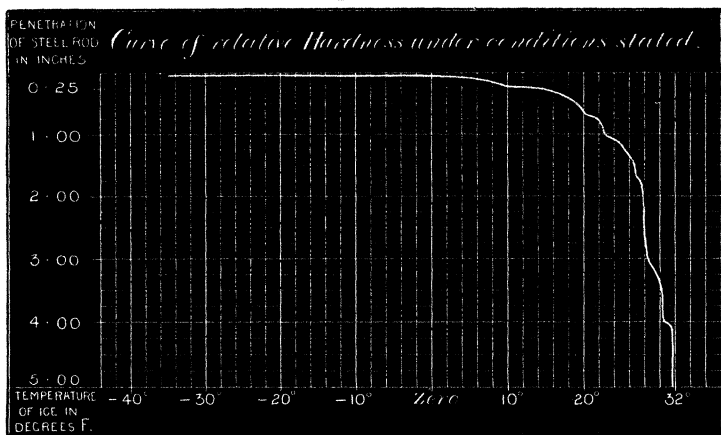
„ „ -30° „ -21° „ = 0·000019744.

SET III.—*Relative Hardness or Penetrability of Ice at Temperatures between -35° F. and $+32^{\circ}$ F.*

The observations were periodically taken during the gradual increase in the temperature of the ice cylinder from -35° F. to $+32^{\circ}$ F. A polished steel rod, 16 inches long by 0·292 inch diameter, blunt at the end, was allowed to penetrate the ice under the influence of a weight of $181\frac{1}{2}$ lbs. resting on its summit. A suitable apparatus was arranged to carry out this set of observations, which is roughly delineated on the sketch, fig. 1.

The relative depths to which the steel rod penetrated the ice under the varied conditions of temperature (which were frequently ascertained by thermometers) compared with the penetrability at -35° F. afforded approximate indications of the relative hardness or penetrability of the pure ice under the conditions of experimentation. The

Table III.—Relative Hardness or Penetrability of Ice at various Temperatures.



The steel rod penetrated at -35° F. 0.043 in., and at zero F. 0.094 in.

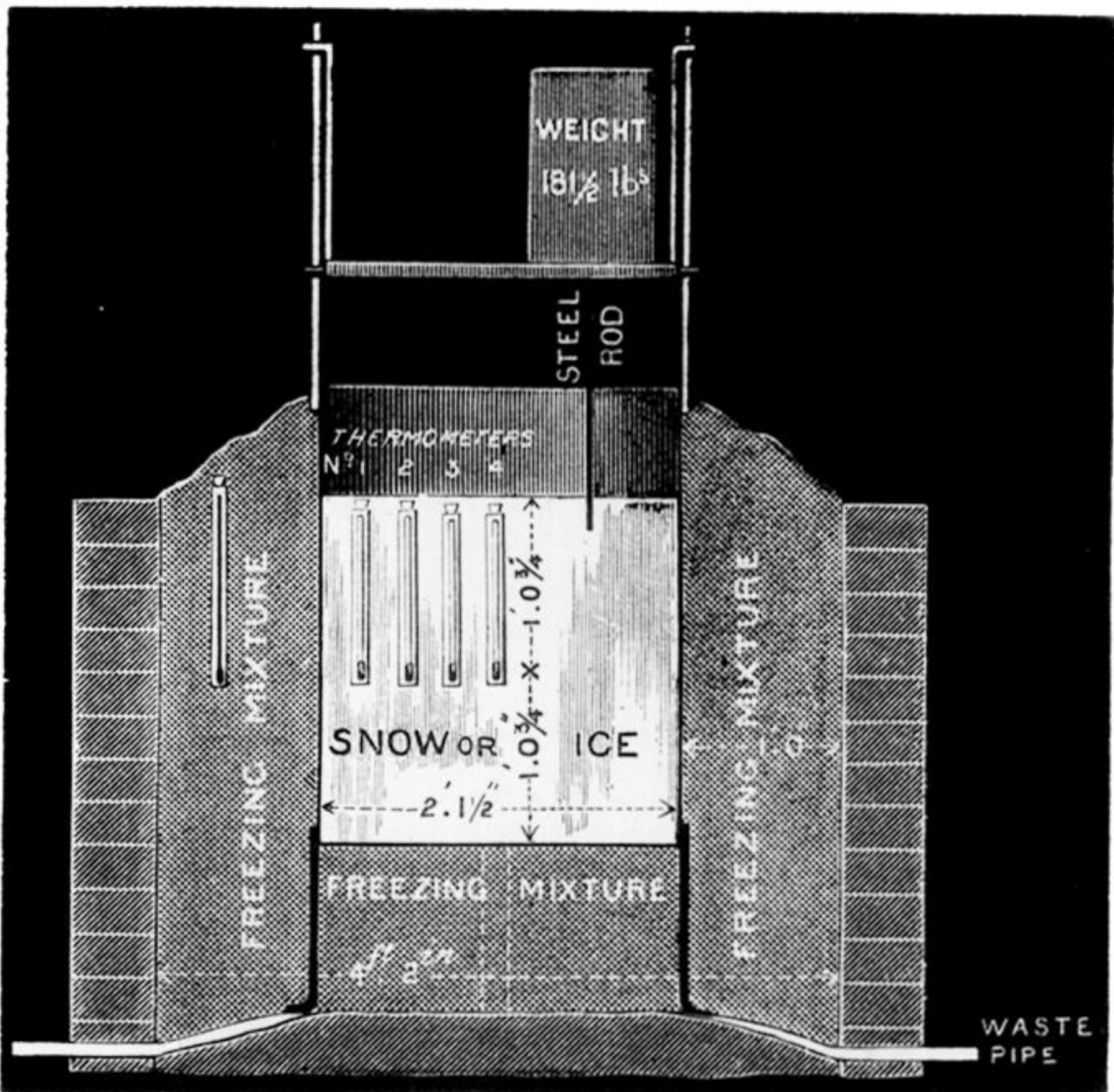
results are given in Table III. These are the average of very many observations. The ice appeared practically to maintain its almost impenetrable hardness from -35° F. until about $+10^{\circ}$ to 20° F., after which its power of resistance to the penetration of the steel rod rapidly decreased with the increase of temperature. It will also be noticed that the relative contraction and dilatation of the ice between the extremes of low temperature employed was considerable. The whole of the experiments were many times repeated to ensure accuracy, and it may be observed that above 20 tons of snow and above 7 tons of salts for freezing mixtures, &c., were consumed in conducting the varied experiments of the investigation.

XIII. "On the Gaseous Constituents of Meteorites." By GERRARD ANSDALL, F.C.S., and Prof. JAMES DEWAR, F.R.S. Received June 10, 1886.

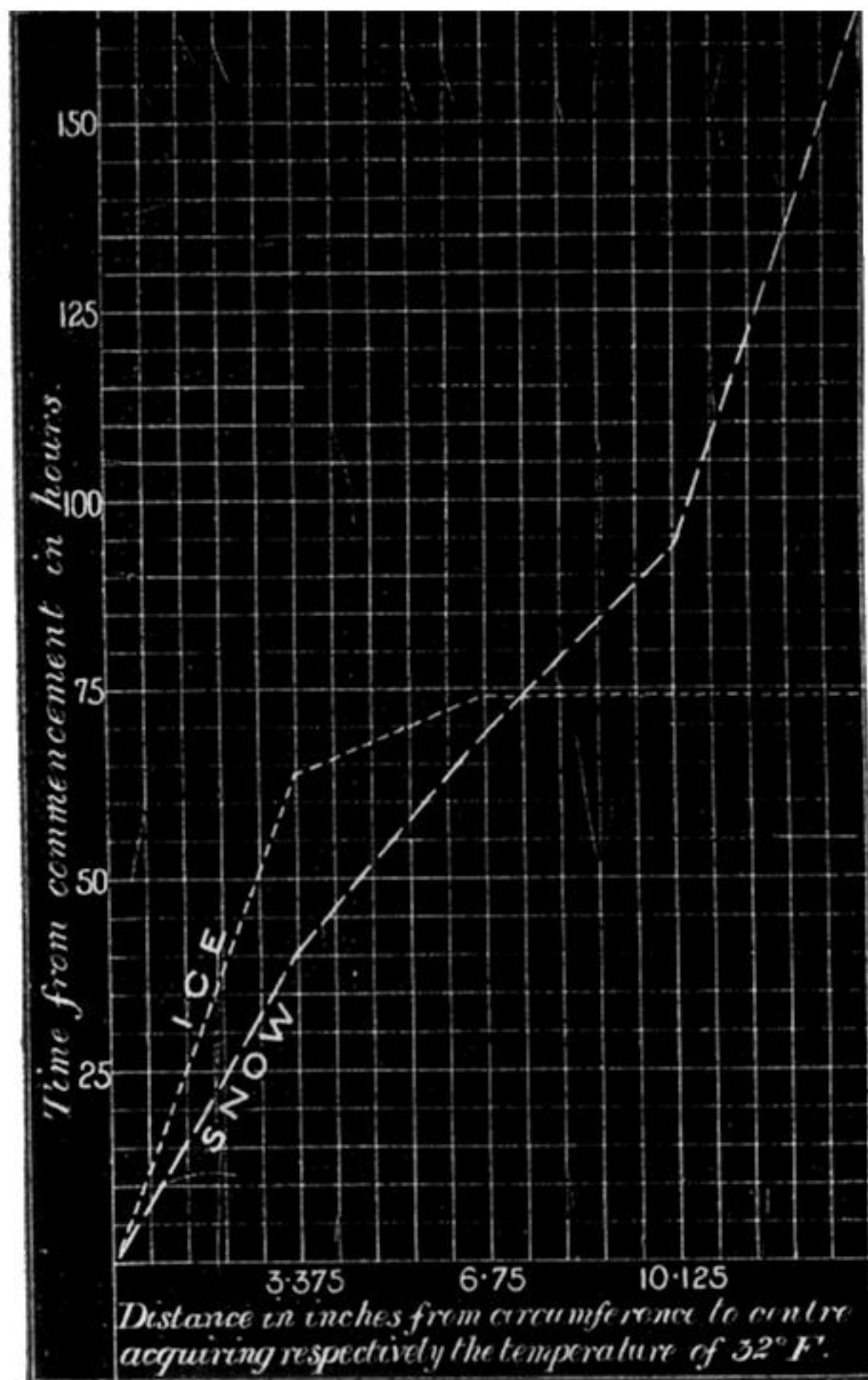
The nature of the occluded gases which are present to a greater or less extent in all meteorites, whether belonging to the iron, stony, or carbonaceous classes, has engaged the attention of but few chemists. It is, nevertheless, an especially interesting and important subject, owing to the uncertainty which still exists as to the origin of these celestial bodies.

Graham ("Proc. Roy. Soc.," vol. 15 (1867), p. 502, was the first who made any experiments in this direction, when he determined the gases occluded in the Lenarto meteoric iron, which yielded 2.85 times its volume of gas, 86 per cent. of which was hydrogen, and 4.5 per

FIG. 1.

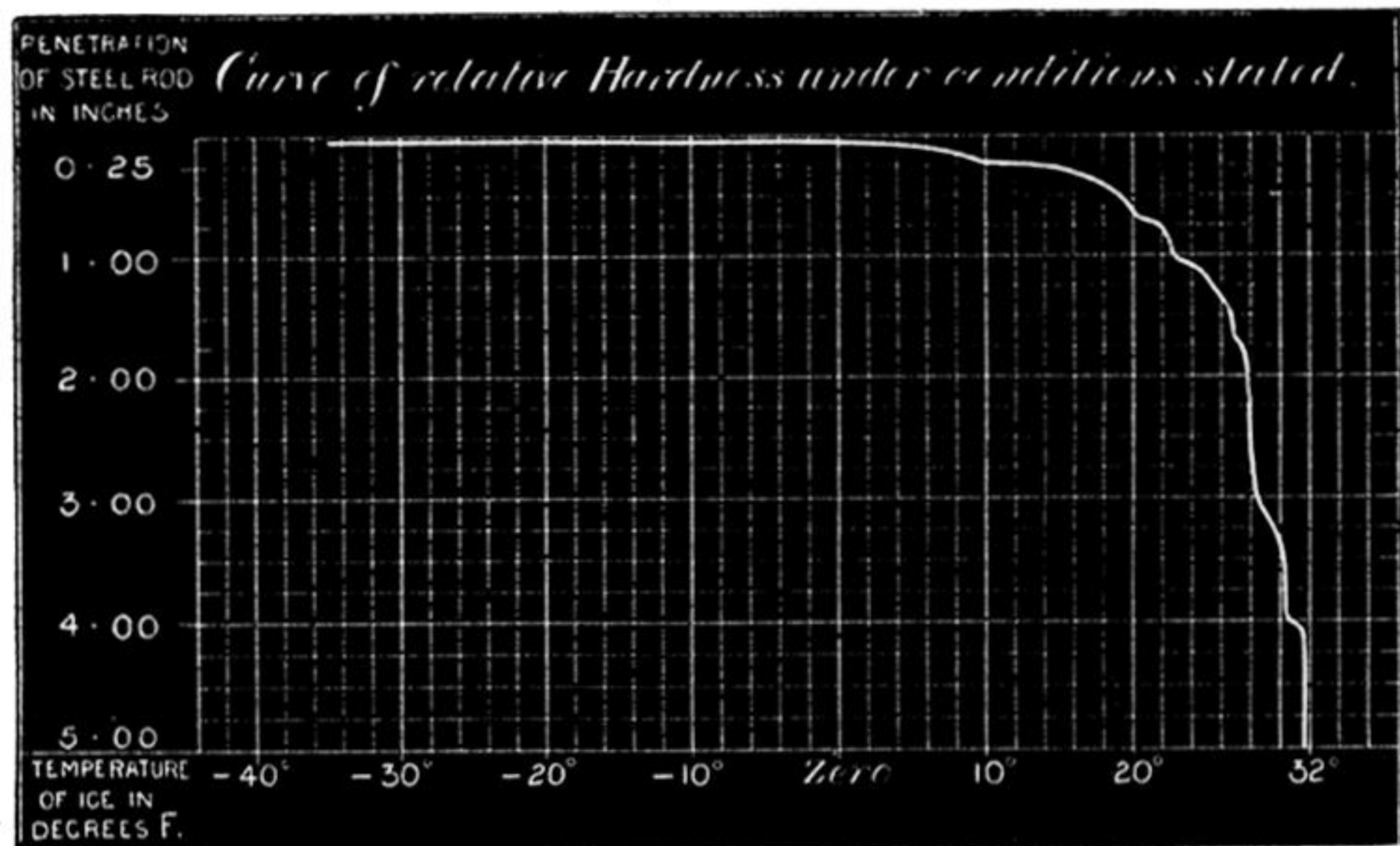


Sectional Elevation.



Temperature of ice and snow cylinders at commencement = Zero (0°) F.
 Temperature surrounding ditto = 32° F.

Table III.—Relative Hardness or Penetrability of Ice at various Temperatures.



The steel rod penetrated at -35° F. 0.043 in., and at zero F. 0.094 in.